

## **SINTESIS KOMPOSIT ZEOLIT-MAGNETIT DARI ZEOLIT ALAM DAN PASIR BESI SEBAGAI ADSORBEN ZAT WARNA MALASIT HIJAU**

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### **INTISARI**

Sintesis komposit zeolit-magnetit berbahan dasar zeolit alam dan pasir besi sebagai adsorben zat warna malasit hijau telah dilakukan. Zeolit alam terlebih dahulu diaktivasi menggunakan larutan  $\text{H}_2\text{SO}_4$  dengan variasi konsentrasi 0,5; 1,0; 2,0; dan 4,0 M. Magnetit diisolasi dari pasir besi menggunakan larutan  $\text{NaOH}$  2,0 M. Sintesis komposit zeolit-magnetit dilakukan melalui metode kopresipitasi. Magnetit hasil isolasi dilarutkan ke dalam larutan  $\text{HCl}$  37% kemudian ditambahkan zeolit alam teraktivasi dengan perbandingan massa 1:1. Campuran ditambahkan dengan larutan pengendap  $\text{NH}_4\text{OH}$  12,5% hingga pH 11. Karakteristik komposit dipelajari melalui karakterisasi FTIR, XRD, SEM-EDX, dan VSM. Kinetika adsorpsi dan isoterm adsorpsi komposit zeolit-magnetit terhadap zat warna malasit hijau dikaji melalui penentuan kondisi optimum untuk parameter pH larutan, waktu kontak adsorpsi, dan konsentrasi awal adsorbat.

Hasil penelitian menunjukkan bahwa proses aktivasi zeolit alam memberikan hasil terbaik dengan menggunakan larutan  $\text{H}_2\text{SO}_4$  1,0 M. Komposit zeolit-magnetit berhasil disintesis dari bahan dasar zeolit alam dan pasir besi. Komposit yang dihasilkan memiliki sifat magnetik, dibuktikan dengan kemampuannya dalam merespon medan magnet eksternal sehingga dapat mempermudah proses pemisahan setelah adsorpsi. Kajian adsorpsi menunjukkan bahwa proses adsorpsi zat warna malasit hijau oleh komposit zeolit-magnetit mengikuti model kinetika orde kedua-semu Ho-McKay dengan konstanta laju adsorpsi  $2,75 \times 10^{-2} \text{ g mg}^{-1} \text{ menit}^{-1}$ , serta isoterm Langmuir dengan nilai  $K_L$  sebesar  $0,217 \text{ L mol}^{-1}$  dan kapasitas adsorpsi maksimum  $196,078 \text{ mg g}^{-1}$ . Parameter termodinamika menunjukkan bahwa adsorpsi terjadi secara spontan dan bersifat endotermis.

Kata kunci: adsorpsi, komposit zeolit-magnetit, magnetit, malasit hijau, zeolit alam.

## **SYNTHESIS OF ZEOLITE-MAGNETITE COMPOSITE FROM NATURAL ZEOLITE AND IRON SAND AS ADSORBENT FOR MALACHITE GREEN DYE**

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### **ABSTRACT**

The synthesis of a zeolite-magnetite composite from natural zeolite and iron sand as an adsorbent for malachite green dye has been conducted. Natural zeolite was first activated using  $\text{H}_2\text{SO}_4$  solution with varying concentrations of 0.5, 1.0, 2.0, and 4.0 M. Magnetite was isolated from iron sand using a 2.0 M NaOH solution. The synthesis of the zeolite-magnetite composite was carried out through a coprecipitation method. The isolated magnetite was dissolved in 37% HCl solution, then mixed with activated natural zeolite at a 1:1 mass ratio. The mixture was added with a 12.5%  $\text{NH}_4\text{OH}$  precipitating solution until reaching a pH of 11. The composite's characteristics were studied through FTIR, XRD, SEM-EDX, and VSM characterizations. Adsorption kinetics and isotherms of the zeolite-magnetite composite for malachite green dye were investigated by determining the optimum conditions for solution pH, adsorption contact time, and initial adsorbate concentration.

The research results indicate that the activation process of natural zeolite yields the best results using a 1.0 M  $\text{H}_2\text{SO}_4$  solution. The zeolite-magnetite composite was successfully synthesized from natural zeolite and iron sand. The resulting composite exhibits magnetic properties, as evidenced by its ability to respond to an external magnetic field, facilitating the separation process after adsorption. Adsorption studies reveal that the adsorption of malachite green dye by the zeolite-magnetite composite follows a pseudo second-order kinetic model with an adsorption rate constant of  $2.75 \times 10^{-2} \text{ g mg}^{-1} \text{ min}^{-1}$ , and a Langmuir isotherm with an  $K_L$  value of  $0,217 \text{ L mol}^{-1}$  and a maximum adsorption capacity of  $196.078 \text{ mg g}^{-1}$ . Thermodynamic parameters indicate that the adsorption is spontaneous and endothermic.

**Keywords:** adsorption, magnetite, malachite green, natural zeolite, zeolite-magnetite composite.